Forest Research
Hamden, Connecticut

United States Department of Agriculture

PREPARED BY Forest Service

Northeastern Forest Experiment Station
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A GLIMPSE OF THE FUTURE

Research progresses through change, which comes in many forms. Although the direction of research at the Center for Biological Control of Northeastern Forest Insects and Diseases in Hamden, Conn., will remain the same--to search for biological control methods for northeastern forest insects and diseases--the acquisition of a site in nearby Ansonia has provided opportunity for expanding research into new areas. As research progresses on microbial insecticides, imported parasites and predators, and host-pest relationships, the possibilities that the site offers for expansion and specialization may be more fully realized with the operation of a primary quarantine facility for research.

Ansonia -- opportunity for expanded research.

Cover photos, clockwise from top left: Hamden laboratory; insect diet production; using the amino acid analyzer; gypsy moth caterpillars rest under a burlap flap in preparation for the night's feast.

FOCUS ON CRUCIAL PEST PROBLEMS

Not all change is desirable, however, as the evidence of damage by insects and diseases to northeastern forests will bear out. More than 58 million acres of valuable forests have been damaged, sometimes beyond recovery, in the past 5 years.

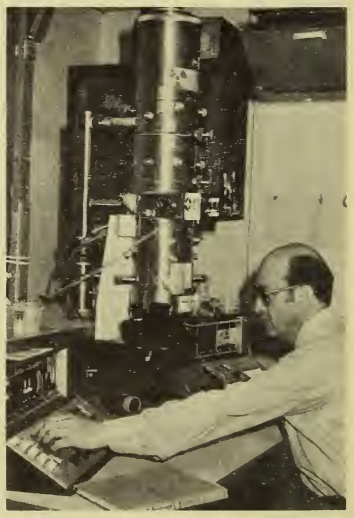
One of the major pests responsible for this damage and among those being researched at Hamden is the gypsy moth. The impacts, initially, are in terms of growth loss and tree mortality, and of esthetic and nontimber value losses to urban plantings and homegrounds. But the loss of trees involves much more. In addition to losses of timber, wood products, and wildlife habitats, established food chains are often seriously disrupted. Protecting valuable forest resources in an environmentally sound manner for everyone's use, enjoyment, and economic benefit is a primary goal of the USDA Forest Service, and the motivation for research at Hamden. The Center for Biological Control and its 34 full-time research staff is one of the 14 research laboratories maintained by the Forest Service's Northeastern Forest Experiment Station.

Insect-defoliated hardwood stand.

Electron microscope close-up of the gypsy moth caterpillar.

For many years, the laboratory at Hamden has been recognized nationally and internationally as the leading center for gypsy moth research. Although still the object of primary emphasis, the gypsy moth and its effects also share attention with other important forest problems such as the spruce budworm, sapstreak disease of sugar maple, and beech bark disease. Basic research results of the laboratory staff have created a more thorough understanding of the bioecology and management of forest pests. The current division into three project areas of research reflects more than 20 years of intense investigation focused on solving the most crucial pest problems of northeastern forests.

Pest and beneficial organisms are cultured throughout the year in a modern insect-rearing facility in support of research at the laboratory. Sophisticated research requires appropriate equipment. Included in the Center's equipment are transmission and scanning electron microscopes, minicomputer with numerous terminals, amino acid analyzer, atomic absorption spectrophotometer, gas liquid chromatographs, electronic drop counting and measuring devices. Lodging and kitchen facilities are available for visiting scientists and cooperators.



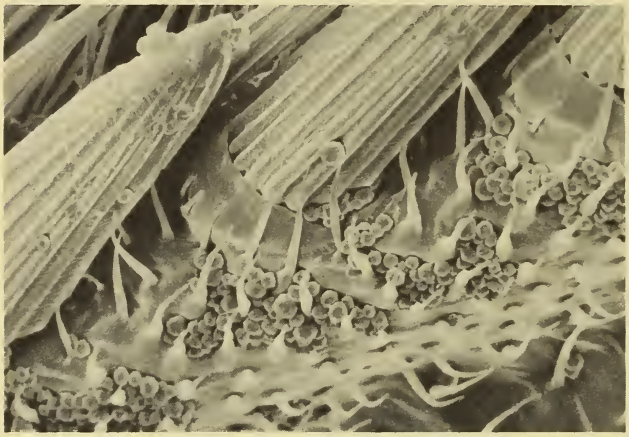
Operating the transmission electron microscope.

INSECT PATHOLOGY AND MICROBIAL CONTROL

The wisdom once was that a chemical spray was the best way to handle an insect or disease problem. But risks to the environment and human health prompted research into the use of microbial agents, which is one of the most important natural control methods studied at Hamden. The team conducting research in this area seeks to understand and capitalize on natural effects of viruses, bacteria, nematodes, and microsporidia on destructive insects. Researchers study the natural history of disease agents, particularly viruses, among insect pest populations and look for better ways to produce, formulate, and apply microbial agents. By knowing the details of the normal course of virus infection, scientists may be better able to determine the factors that trigger virus outbreaks or to use them more effectively. Researchers also explore the roles that other agents or vectors play in transmitting virus diseases. For example, several gypsy moth parasites have shown the capability to transmit gypsy moth virus.

Scientist checks seedlings used in spray tower test of microbial insecticides.

A major achievement by the group, for which they received the USDA Superior Service Award, was the research and development leading to the registration of the gypsy moth virus product, Gypchek . Work continues to improve the formulation of this product, to determine better ways of utilizing the virus, and to select for more virulent strains. Through the unit's research, Neochek , a very effective virus of the European pine sawfly, was developed and registered.



Close-up of parasite wing shows inclusion bodies of gypsy moth virus.

In addition to the important work done with insect viruses, the group has had a major impact on the acceptance and use of the bacterium Bacillus thuringiensis (Bt) for management of the spruce budworm and gypsy moth. Research is being conducted on Bt strain selection and potency evaluations of Bt. A new strain isolated by the Hamden group has shown significant improvement over the commercial strain and is being produced by commercial firms.

At the Ansonia site, the unit is developing the means to evaluate microbial sprays. Here, simulated aerial spray droplet size and coverage, ultraviolet and rain degradation, and deposit analysis are carried out.

The group maintains a virus and Bt reference bank and provides all quality control, storage and distribution for the Forest Service stock of Gypchek and Neochek .

The unit is fully equipped to support aerial and ground field tests with candidate microorganisms and newly developed formulations.

ECOLOGY AND MANAGEMENT OF NORTHEASTERN FOREST INSECT PESTS

Understanding and managing forest insect pests is the complex goal of another research group at Hamden that is determining why forest insect populations, particularly the gypsy moth, vary in number and quality over time. The group is developing the needed concepts and methods, through laboratory and field studies, to apply this information to specific forest pest management systems with the use of computer simulation models.

The work involves studying gypsy moth at low densities both in forest and urban situations. Current and historical data on the gypsy moth are analyzed to determine the relationship between insect populations and many environmental factors. For instance, is it leaf chemistry or habitat that makes a tree more susceptible to insect attack? What factors mediate insect behavior and can they be used to accurately measure densities and predict future population trends? How do beneficial organisms regulate pest numbers? Scientists have constructed a gypsy moth-forest system model for both research and management uses. Eventually, a more thorough understanding of sparse gypsy moth population dynamics will permit integrating various biological and silvicultural controls into a cohesive management practice.

Parasite rearing at Hamden.

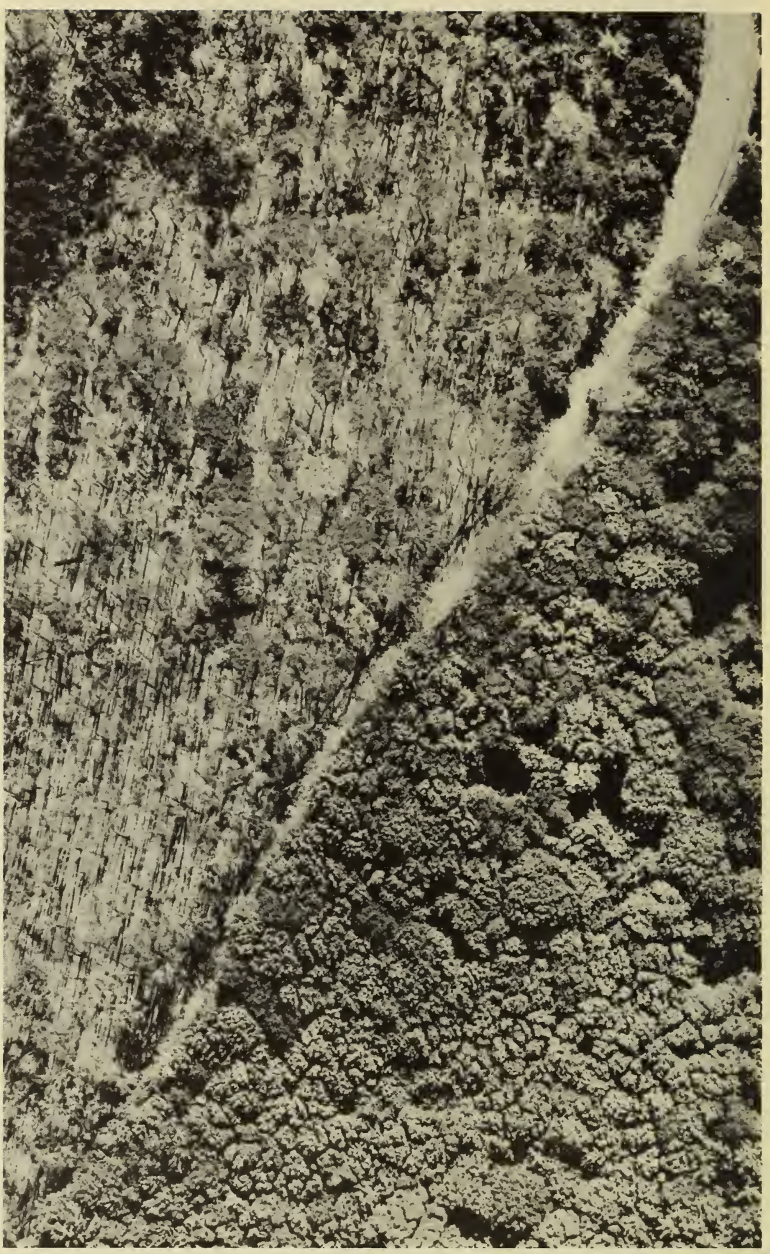
Other team members are interested in the role of parasites and predators in controlling gypsy moth populations. Mice, wasps, birds, invertebrates, and raccoons are examples of insect regulating agents being studied. Researchers want to maximize the effectiveness of these natural control agents in pest management systems. They study the dynamic processes involved in the interaction of parasites and predators, and the impact of type and condition of the forest upon pests such as gypsy moth. Such processes include competition, augmentation, and interaction among guilds of beneficial organisms. Because gypsy moth is not native to the United States, effective indigenous parasites do not exist. This has prompted the importation and evaluation of foreign parasites, as well as bacteria, viruses, and protozoans as possible means of control. The primary quarantine facility at Ansonia will maintain such organisms under strict quarantine conditions for research, evaluation, and eventually for use against pests in the field.

Raccoons and mice are natural insect control agents. The mouse receives an implant that will transmit signals to scientists studying the rodent's habits.

Sterile male gypsy moths are released in field tests.

Another approach to biological control is being explored by team members who cooperate with other federal and state agencies in releasing sterile and partially sterile gypsy moth males or eggs to suppress outbreaks before they reach defoliating levels. When the sterile males mate with wild females, the result is sterile offspring. Field tests in several states have resulted in over 99% reduction of gypsy moth in the test area. Scientists are accelerating efforts on partial or inherited sterility techniques for suppressing gypsy moth populations.

A pest management system based on integrated control strategies for oak-hickory forest pests in the Northeast has been implemented and is being evaluated. Considering the current controversy over chemical sprays, researchers are placing the most hope for control on integrated pest management strategies that require developing sensitive insect-and disease-monitoring systems so that appropriate biological or silvicultural control action can be initiated.



Untreated, the stand on the left bore severe defoliation by the gypsy moth in contrast to its treated neighbor.

HOST-PEST INTERACTIONS

Nowhere are the complicated dynamics of forest insect and disease problems more evident than in the area of research at Hamden covering dieback and decline diseases. The problems occur when trees, weakened by such environmental stresses as insect defoliation, extremes of weather, or attacks by scale insects are invaded and often killed by opportunistic organisms. Researchers in this group investigate the causes, patterns of development, and characteristics of these stress-triggered tree diseases. Over the years their research focus has included ash dieback and maple decline, the currently troublesome problems of beech bark disease and the decline and mortality of oaks following defoliation by the gypsy moth, and the potentially serious disease of sugar maple called sapstreak. They seek answers to why oaks under stress are vulnerable to

Sugar maple hit by sapstreak disease shows signs of decline.

root-killing fungi, why beech trees stressed by beech scale are easy prey for bark canker fungi, and why sugar maples are sometimes attacked and killed by a common stain fungus after they have been injured. Studies are also evaluating the possible roles that atmospheric deposition stress may play in triggering tree diseases. Concurrent studies are underway to estimate the effects of these diseases on the rates of growth, mortality, and the development of defect in tree hosts. In addition, models are being developed which predict the consequences of various control strategies for the gypsy moth, the primary initiator of oak decline.

Fans of white fungus characterize Armillaria in nature; in laboratory cultures (inset), "shoestring" growths appear.

Can this tree "meet the challange" applied by scientists and resist beech bark disease?

In line with the emphasis at Hamden on biological controls, researchers are also evaluating the use of mycoparasites and mycoantagonists, protection by bark ephiphytes, and disease-resistant trees in reducing losses to dieback-decline diseases.

Resistant beech tree (left) appears vigorous next to its diseased neighbors.

Research encompasses field studies to identify the ecological relationships of interacting organisms and laboratory studies designed to clarify the biochemical bases for these relationships. From detailed chemical analysis of tissues affected by stress and colonized by the array of interacting organisms, scientists hope to identify mechanisms of resistance and susceptibility. Developing ways to select trees resistant to the initiating stresses or to the colonizing organisms are major goals of the research.

More information on the research at Hamden is available from the Center for Biological Control of Northeastern Forest Insects and Diseases, 51 Mill Pond Road, Hamden, CT 06514, tel. (203)773-2021.

Before and After -- beech bark disease can turn tall, straight, smooth trees into short, grossly defective ones.

Headquarters of the Northeastern Forest Experiment Station are in Broomall, Pa. Field laboratories are maintained at:

- Amherst, Massachusetts, in cooperation with the University of Massachusetts.
- Berea, Kentucky, in cooperation with Berea College.
- Burlington, Vermont, in cooperation with the University of Vermont.
- Delaware, Ohio.
- Durham, New Hampshire, in cooperation with the University of New Hampshire.
- Hamden, Connecticut, in cooperation with Yale University.
- Morgantown, West Virginia, in cooperation with West Virginia University, Morgantown.
- Orono, Maine, in cooperation with the University of Maine, Orono.
- Parsons, West Virginia.
- Princeton, West Virginia.
- Syracuse, New York, in cooperation with the State University of New York College of Environmental Sciences and Forestry at Syracuse University, Syracuse.
- University Park, Pennsylvania, in cooperation with the Pennsylvania State University.
- Warren, Pennsylvania.